2.3 Saline Soil Reclamation Experiment at the University of Saskatchewan, Goodale Farm

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INTRODUCTION AND OBJECTIVE

In October of 1984 a test drilling program on the University of Saskatchewan Goodale Farm (SE4-36-4-W3) established that artesian discharge from the Forestry Farm aquifer was a major factor in salinization. The test drilling program included the completion of a production well capable of yielding 20 gallons per minute as a free flowing well or much larger quantities if pumped. The objective of the project herein reported was to determine the feasibility of utilizing the water from the aquifer for leaching and soil improvement. It was recognized from the outset that addition of this moderately saline water, without provision for drainage, could not result in any permanent and long term reclamation. However the possibilities for temporary soil improvement were unknown.

MATERIALS AND METHODS

The characteristics of the production well are given in Table 2.3.1. The Forestry Farm aquifer is a glacial aquifer with moderately mineralized (3.1 dS/m) water, with a relatively low SAR value (4.4).

During the summer of 1985, plots were established on two soil areas herein referred to as the north and south plots. The water distribution system included plastic hose and garden-type soaker hoses. The quantity of water was monitored with a regular domestic water meter. The plots were established in July on an existing wheat crop. Because of disturbance by wind, it was necessary to construct plywood shelters around the individual plots. Individual plots were 8 feet by 20 feet and there were four replications on each of the north and south plots.

Table 2.3.1 Physical description of well and chemical characteristics of ground water.

Total depth	=	124 feet
Washdown value placed on bottom of screen		
Screen	=	10 feet of 15 slot stainless steel 5" dia.
Casing	=	5" threaded PVC pipe
Washdown completion and cemented from 112 feet to 20 feet		
Static water level	=	10 feet above ground surface

Chemical characteristics of water (sampled July 7, 1989):

EC	=	3.1 dS/m
pH	=	7.3
Na^+	=	356 ppm
Ca^{++}	=	274 ppm
Mg^{++}	=	139 ppm
K^+	=	25 ppm
Cl^-	=	78 ppm
$SO_4^=$	=	1455 ppm
HCO_3^-	=	525 ppm
SAR	=	4.4 ppm

The technique utilized in 1985 was not considered satisfactory for a long term experiment. Therefore, in 1986 an irrigation system was constructed utilizing drip irrigation hose. This overcame almost all the problems associated with the earlier system and was very successful. The drip lines were set in place after the barley crop was up and remained there until leaching was completed in the autumn of each year from 1986 through 1989.

The quantities of rainfall and irrigation water applied throughout the experiment are given in Table 2.3.2. In 1986 the rainfall in June and July was adequate to support normal crop growth, but in both 1987 and 1988, June and July rainfall was very low,

Table 2.3.2 Irrigation and rainfall data (mm).

Year	May		June		July		August		September		Total rain	Total irrigated
	Rain	Irrigated	Rain	Irrigated	Rain	Irrigated	Rain	Irrigated	Rain	Irrigated		
North plot												
1986	14	0	21	80	127	0	15	0	62	0	238	80
1987	29	0	10	183	29	172	46	74	12	0	126	429
1988	21	69	3	70	39	277	69	156	24	294	156	867
1989	71	0	34	141	49	368	33	99	4	0	191	608
South plot												
1986	14	0	21	243	127	0	15	0	62	0	238	243
1987	29	0	10	184	29	183	46	59	12	0	126	427
1988	21	60	3	52	39	243	69	85	24	238	156	678
1989	71	0	34	176	49	381	33	55	4	0	191	612

In 1985 the north plot received 205 mm irrigation, while in 1985 the south plot received 125 mm irrigation.

necessitating large irrigation additions. In 1988 the extremely dry spring conditions necessitated a significant irrigation just after seeding.

The soil characteristics of the two plot areas are provided in Table 2.3.3. The two plot areas were similar with respect to organic matter, clay content and cation exchange

Table 2.3.3 Soil physical and chemical characteristics.

Horizon	Depth (cm)	% sand	% clay	% O.M.	C.E.C. me/100 g	Saturation extract EC dS/cm	Saturation extract SAR	pH
				North plot				
Ap	0-15	57	18	4.8	22	6	3	6.9
Bm	15-32	53	18	1.9	15	10	8	7.2
Bm-Ccasa	32-40	38	32	1.6	22	11	8	8.0
$Ccasa_1$	40-60	45	27	0.6	14	10	7	8.3
$Ccasa_2$	60-80	37	25	0.5	14	9	7	8.4
$Ccasa_3$	80-110	42	27	0.4	13	7	6	8.2
Cks_1	110-130	47	25	0.3	13	7	5	8.2
Cks_2	130-145	47	24	<0.1	15	6	5	8.1
				South plot				
Ap	0-15	50	20	4.4	23	25	18	7.4
Ah-Bm	15-25	49	18	1.2	15	18	15	8.0
Bhsa	25-55	36	30	1.1	20	15	13	8.2
Csaca	55-85	47	28	0.3	12	10	9	8.2
$Ccasa_1$	85-115	53	22	<0.1	15	9	9	8.2
$Ccasa_2$	115-145	50	22	<0.1	14	9	9	8.2
$Ccasa_3$	145-200	50	24	<0.1	16	13	10	8.0
$Ccasa_4$	200-250	49	25	<0.1	17	15	11	8.1
$Ccasa_5$	250-290	40	26	<0.1	13	13	9	8.0

Samples taken from non-irrigated area adjacent to plot in September 1989.

capacity. The north plot was only moderately saline in the surface soil and severely saline in the subsoil, whereas the south plot was very severely saline in the surface soil and severely saline in the subsoil.

RESULTS AND DISCUSSION

The yield data for total dry matter and grain yield are provided in Tables 2.3.4 and 2.3.5, respectively. In the south plot, total dry matter was increased by about 50% in 1986 and by several-fold in each of the subsequent years. In the north plot, total dry matter yields were little affected in 1986, but increased by several-fold in each of the subsequent years.

Table 2.3.4 The effect of irrigation on barley yield (total dry matter, kg/ha).

	1986	1987	1988	1989
	South plot			
Dryland	6123	989	255	3006
Irrigated	9824	6033	8556	13565
	North plot			
Dryland	9465	1273	3914	3997
Irrigated	10422	7146	10336	10187

Table 2.3.5 The effect of irrigation on barley yield (grain yield, kg/ha).

	1986	1988	1989
	South plot		
Dryland	2109	13	896
Irrigated	4267	3166	5760
	North plot		
Dryland	3776	571	1199
Irrigated	4105	4683	4239

Note: In 1987 no grain yield data was available due to wild oat infestation.

Grain yield data (Table 2.3.5) were not reported in 1987 because of an infestation of wild oats. In that year the total dry matter (barley plus wild oats) was harvested and reported as total dry matter yield. In the south plot, grain yield was approximately doubled in 1986 and quadrupled in 1989. In 1988 essentially no grain yield was obtained on the south plot without the benefit of irrigation. On the north plot, grain yield increases were small in 1986 and several-fold in both 1988 and 1989.

From the grain yield data it is clear that application of the moderately saline water over a period of four years resulted in very pronounced yield increases and no detrimental crop effects.

Soil samples were taken at the beginning and at the end of the experiment and the results of these analyses are presented graphically in Figures 2.3.1 and 2.3.2 for the south plot and Figures 2.3.3 and 2.3.4 for the north plot.

In the south plot under dryland conditions, the main salt accumulation was at 15-60 cm in 1985 but 0-30 in 1989. In 1985 samples were taken to only 90 cm, but in 1989 samples were obtained to a depth of 240 cm. In the south irrigated plot, the salt bulge has been moved from the 0-60 cm depth in 1985 to the 60-90 cm depth in 1989.

The salt profile for the north plot was slightly different under dryland conditions in 1989 than in 1985. In 1985 the peak appeared to be at about 90 cm, whereas in 1989 the peak is at approximately 60 cm. Under irrigated conditions, however, the salt bulge had been moved down to approximately 90-120 cm in 1989 (Figure 2.3.4).

Thus, it is evident that considerable downward movement of salts has occurred resulting in an improvement in the plant growth conditions in the upper 60 cm of soil, particularly in the south plot which was most strongly affected by salinity.

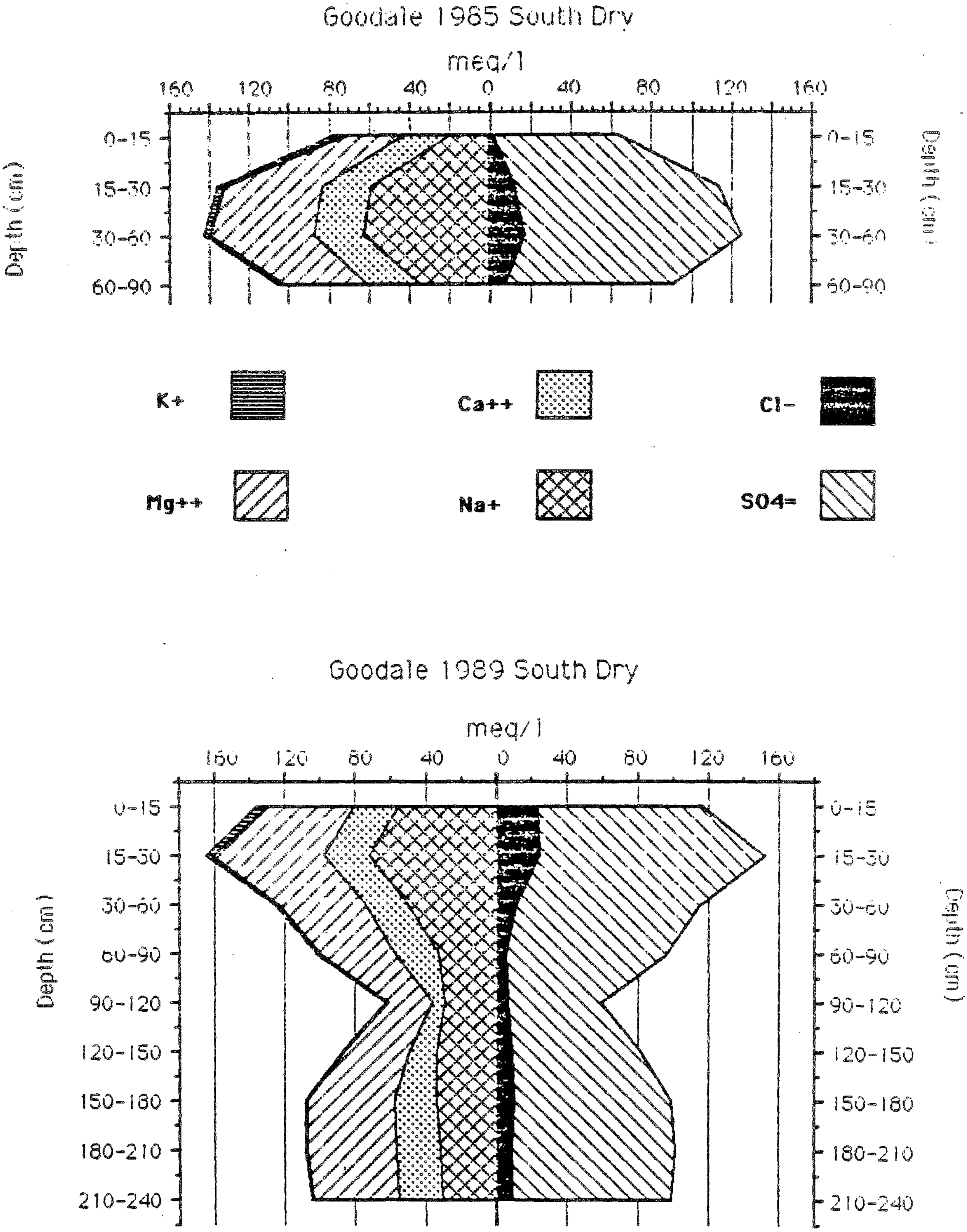
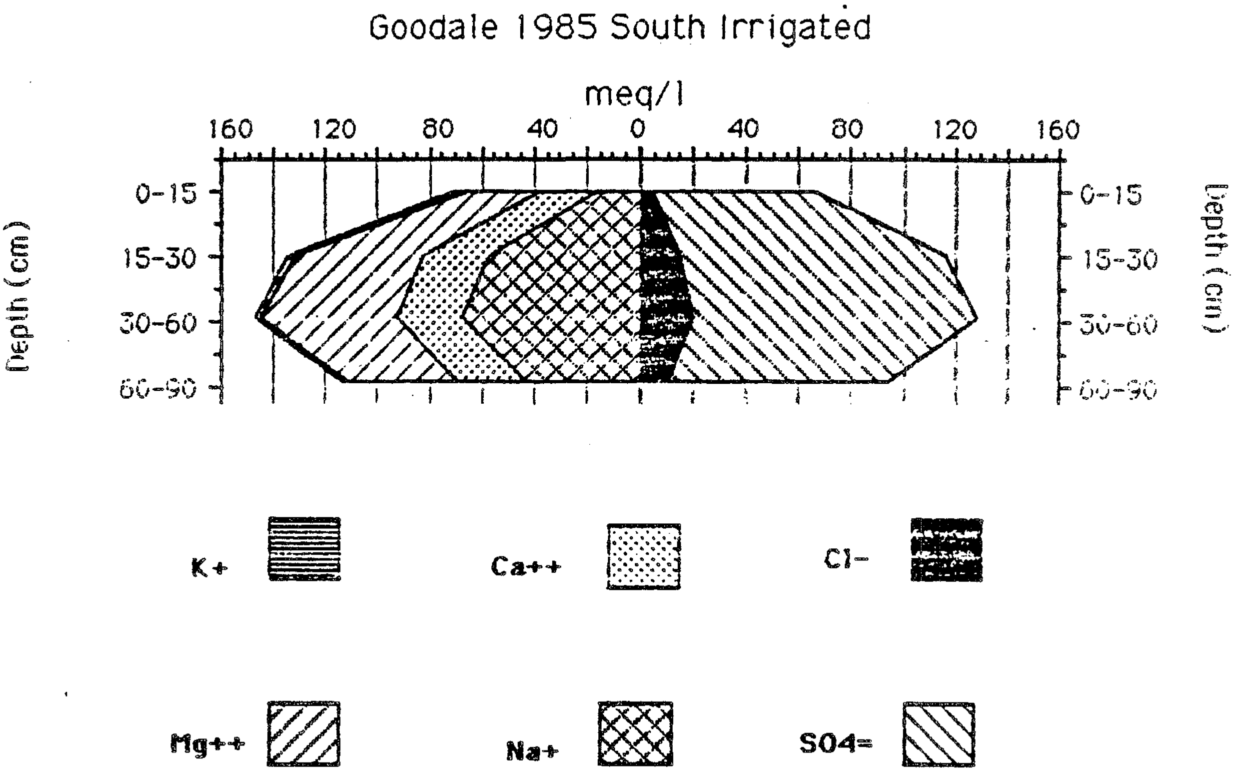


Figure 2.3.1 Salt profiles in 1985 and 1989 on the south dryland plots.



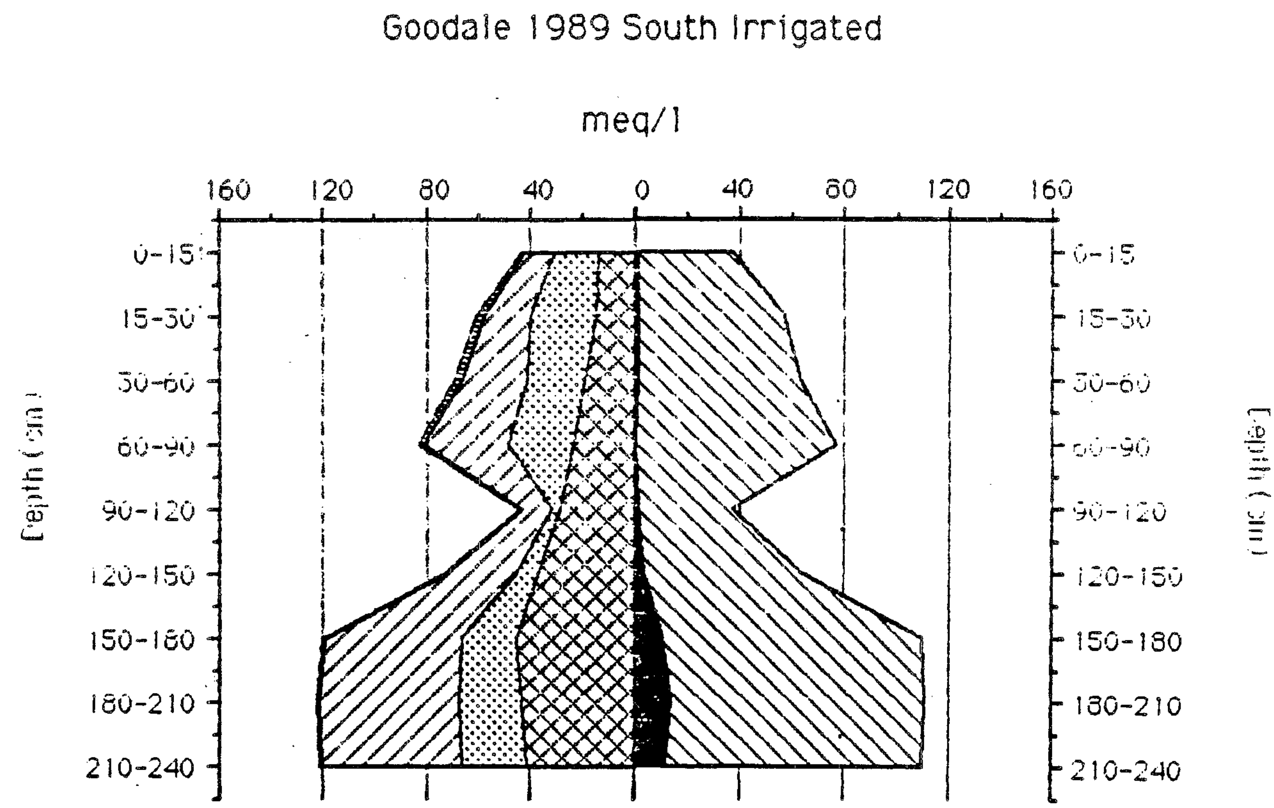


Figure 2.3.2 Salt profiles in 1985 and 1989 on the south irrigated plots.

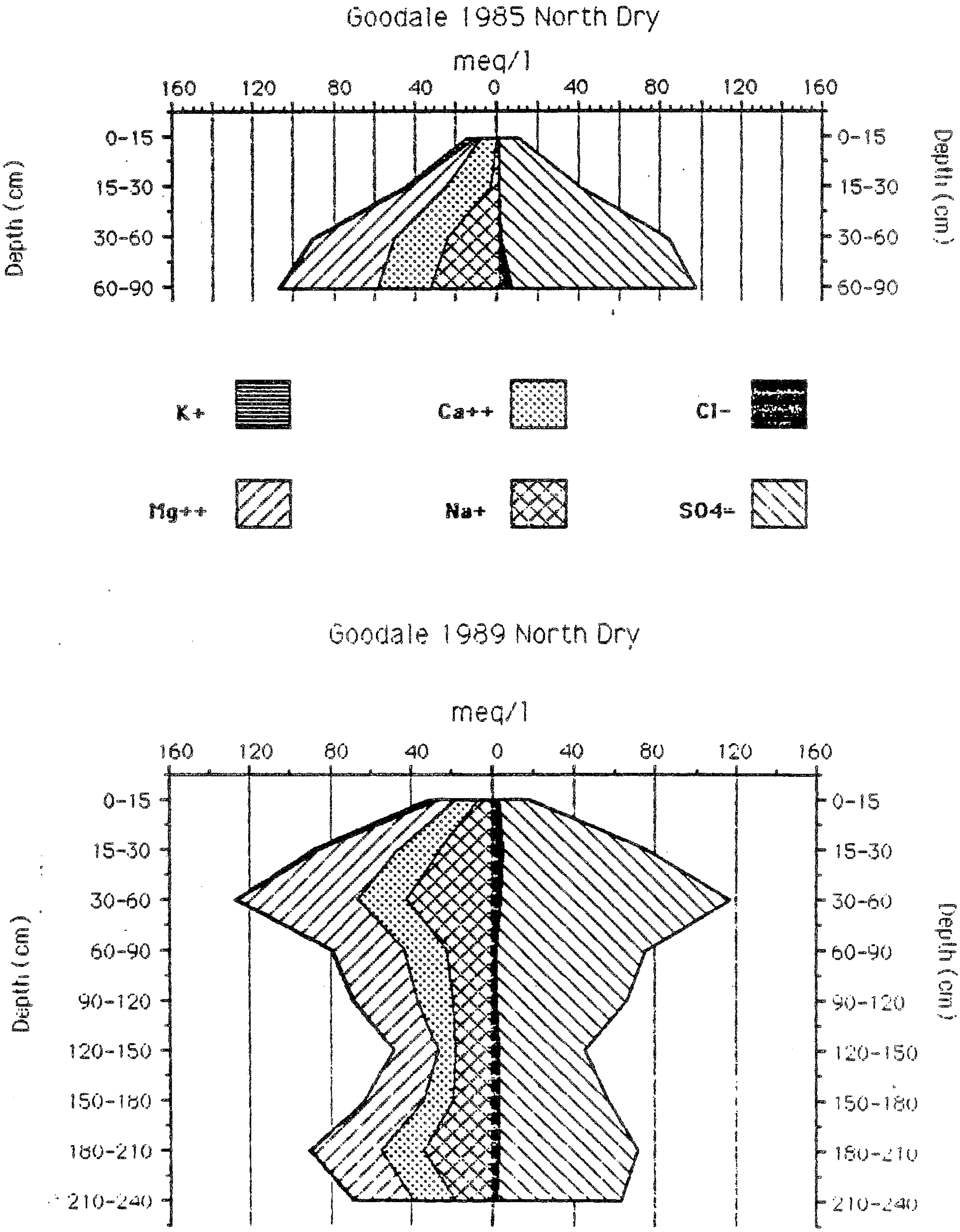


Figure 2.3.3 Salt profiles in 1985 and 1989 on the north dryland plots.

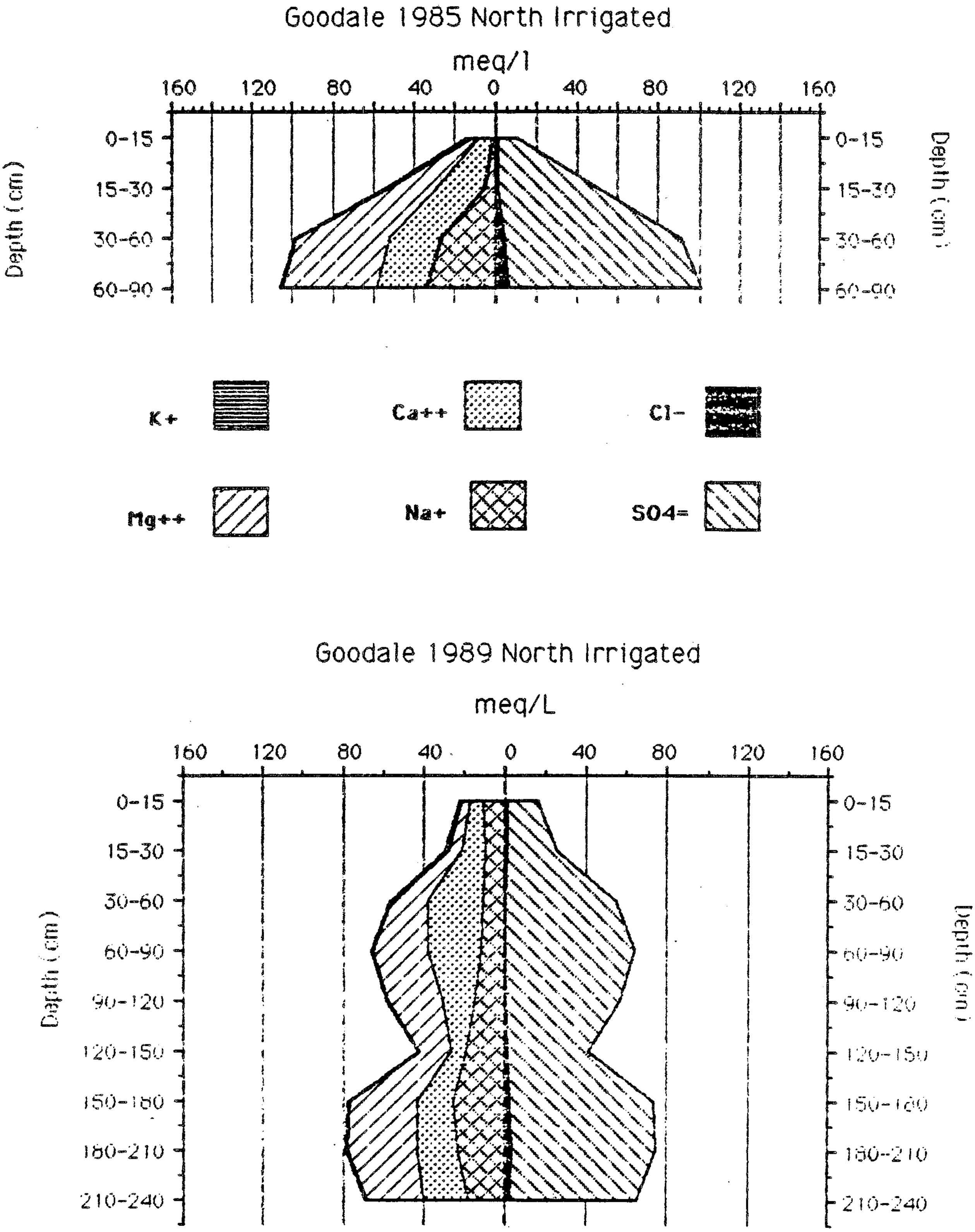


Figure 2.3.4 Salt profiles in 1985 and 1989 on the north irrigated plots.

CONCLUSION

On the basis of the data in this experiment, it is concluded that some improvement in surface soil salinity, and hence, in crop yields, is possible by utilizing even moderately saline water for leaching purposes. However, it must be clearly understood that such a procedure would not be successful in the long term. With the water being utilized, approximately 700 lbs of salt per acre are being added with each inch of irrigation water. With no provision for subsoil drainage or salt removal, in the long term the salts must accumulate or waterlogging must result. This experiment has been concluded and no further investigations are planned.